Establishing a Long Term Avian Survey to Monitor Restoration Success of a Wet Prairie

Research Thesis

Presented in partial fulfillment of the requirements for graduation *with research distinction* in the undergraduate colleges of The Ohio State University.

By

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Abstract

Ohio has lost over 90% of its original wetlands and 99% of its native tallgrass prairies, resulting in the decline of key ecosystem services such as water purification, flood prevention and critical wildlife habitat. Successful wetland and grassland restoration is crucial for the re-establishment of well-functioning habitats. Due to the diversity of species and niches, birds are highly useful and common indicators of the progress of ecosystem recovery after restoration. The objective of this study is to establish a long-term point count survey in a large restored wet prairie to monitor bird species abundance and diversity. Continued monitoring will document any changes in bird species presence and abundance relative to ongoing habitat succession and management. The survey location was in a 750 acre restored wet prairie at Battelle Darby Creek Metro Park, 18 km west of Columbus, Ohio. Franklin County Metro Parks expressed special interest in the status of Ohio species considered threatened or of concern, such as Henslow's Sparrow (*Ammodramus henslowii*) and Marsh Wren (*Cistothorus palustris*). In order to monitor these bird species, I established a network of survey points, with 27 count stations spaced 250 meters apart. In May and early June of 2017, I completed three surveys using five-minute counts during which I detected species presence with auditory or visual cues within a 50 meter radius. Using the "unmarked" package in Program R, abundance estimates were calculated for two wetland species (Marsh Wren and Willow Flycatcher) and two grassland species (Henslow's Sparrow and Grasshopper Sparrow), each being a specialist species in relation to habitat type. As the percent of woody vegetation increased, the estimated abundances of Henslow's Sparrow and

Grasshopper Sparrow decreased, while the estimated abundance of Willow Flycatcher increased. Based on these results demonstrating differing habitat preferences, I recommend a rotational management approach to ensure the presence of suitable habitat for multiple species in the wet prairie.

Introduction

North American grasslands and wetlands represent some of the most heavily impacted ecosystems in the world. Grasslands are the most fragmented and threatened terrestrial biomes due to their potential for high agricultural productivity (Gerla et al. 2012). Estimates show that 80% of North American grassland ecosystems were lost since the mid-1800s (Brennan et al. 2005). In areas where soils and topography have been conducive to crop production, less than 0.1% of tallgrass prairie remains (Brennan et al. 2005). Similarly, wetlands have been extensively drained and filled for agriculture and development in North America. The U.S. has lost more than half of all wetlands present prior to European colonization with concentrated losses in the Midwest (Sucik et al. 2010). Ohio alone has lost over 90% of its original wetlands and 99% of its native tallgrass prairies (Gibson 2015).

Due to such significant losses of habitat and increased fragmentation of remnants, restoration of grasslands and wetlands presents the best method for supporting and increasing biodiversity in these ecosystems (Brennan et al. 2005). The successful restoration of these ecosystems requires continued monitoring to track successional changes and to validate management practices. Long-term bird monitoring surveys are an effective and efficient method to document the impact of restoration succession. Birds are valuable indicators of overall ecosystem health due to their diversity in habitat requirements and preferences, and relatively high detectability. Not surprisingly, grassland birds have experienced some of the steepest population declines recorded as prairie habitats have become scarce (Rosenberg et al. 2016). Modern agricultural landscapes fail to provide grassland birds with suitable habitat as crops are grown right to the road edge (i.e. eliminating marginal habitats and hedgerows) and are heavily sprayed with herbicides that eliminate native prairie plants (Brennan et al. 2005). While not as dire a reduction as grassland birds, wetland birds have also experienced sharp population declines. Approximately one-third of North American bird species depend on wetlands for food, shelter or breeding (Stewart 2016). Twenty four percent of 163 bird species that breed in wetlands are Species of Concern, including ten federally listed as endangered or threatened (North American Bird Conservation Initiative 2009).

This study focuses on two grassland bird species; *Ammodramus henslowii* (Henslow's Sparrow, HESP) and *Ammodramus savannarum* (Grasshopper Sparrow, GRSP) and two wetland species; *Cistothorus palustris* (Marsh Wren, MAWR) and *Empidonax traillii* (Willow Flycatcher, WIFL) in a restored wet prairie in Central Ohio. I selected these bird species as they are either threatened, of concern or indicators of good-quality habitat.

Ammodramus henslowii is a Species of Concern in Ohio with an estimated state population of 11,500 singing males. Data from Ohio Breeding Bird Surveys indicate a 4.2 percent annual population decrease since the mid 1960s (Rodewald et al. 2016). Partners in Flight named the Henslow's Sparrow as the top priority for grassland bird conservation in Midwestern North America (Herkert et al. 2002). Henslow's sparrows are found on or near the ground, in dense cover (Rodewald et al. 2016).

Ammodramus savannarum are less specialized than other grassland sparrows as they can be found in a variety of native and cultivated grasslands. The Ohio Breeding Bird Atlas (Rodewald et al. 2016) estimates the statewide population of *Ammodramus savannarum* singing males to be 170,000. Breeding bird survey results report a continual population decline since the mid-1960s and an average decline of 5.5% per year since the first Atlas in 1987 (Rodewald et al. 2016). If these current rates persist, the Grasshopper Sparrow species will lose another half of its population by 2065 (Vickery 1996, Rosenberg et al. 2016).

Cistothorus palustris is a Species of Concern in Ohio due to its localized distribution and small population size. This species inhabits emergent marshes with cattails, sedges, bulrushes and *Phragmites* (Rodewald et al. 2016). While a Species of Concern in Ohio, the Marsh Wren is a common bird outside Ohio, whose populations have increased by 130% between 1966 and 2015 across North America (Kroodsma and Verner 2013). Due to the small population numbers of *Cistothorus palustris* in Ohio, population estimates could not be generated for the Ohio Breeding Bird Atlas (Rodewald et al. 2016).

Empidonax traillii inhabit shrubby thickets adjacent to streams, wetlands and ponds. The Ohio Breeding Bird Atlas estimates the statewide population of *Empidonax traillii* at 150,000 singing males. In Ohio, their populations have increased by 0.7% per year since the mid-1960s, while across North America their populations have declined by 1.6% per year during the same period (Rodewald et al. 2016). In total, Willow Flycatcher populations have decreased by 46% from 1970 to 2014 (Sedgwick 2000).

Using these species as indicators of crucial wetland and grassland habitat requirements, I hope to establish a baseline to document how their abundance changes in relation to habitat succession in the future. Specifically, I established surveys within the recently restored wet prairie in Battelle Darby Creek Metro Park to record focal species abundance in relation to habitat composition. By conducting this study, my overall goal was to establish a long-term monitoring effort that would serve to document both bird species diversity and habitat usage and to aid decision making for adaptive management practices.

Methods

Study Location

My study took place on a 750 acre restored wet prairie in Battelle Darby Creek Metro Park, 18 km west of Columbus, OH (39°54'54.74"N, 83°12'36.51"W). This bird monitoring survey is the first long-term survey to measure the impacts of succession on bird species diversity and abundance after the restoration project's completion in 2012. The 750 acre restoration site consists of two different habitat types. The southern 500 acres was reconstructed and seeded in 2010 and is managed as a wet prairie. This is a mosaic habitat with wet prairie, drier savannah, emergent cattail marshes and several large and deep wetlands with open water. The northern 150 acres was completed in 2012 and is managed as a wet prairie savannah. The original planting included: Indian grass, big bluestem, little bluestem, prairie dropseed and Virginia rye grass. Forbes included: prairie false indigo, round-headed bush clover, prairie coneflower, purple coneflower, whorled rosinweed, prairie dock, purple bergamot, black-eyed susan, obedient plant, square-stemmed monkey flower, ashy sunflower and swamp milkweed. In the wet prairie savannah, Metro Parks planted 250 five-gallon containerized burr oaks. Also included in the study is an additional young swamp forest, restored and planted in 2010 just north of Kuhlwien Road (John Watts, personal communication).

I established 27 point count stations within the wet prairie, wet prairie savannah and adjacent swamp forest. Survey points were 250 meters apart and were predominantly located along established trails for ease of access. This point placement adjacent to trails followed similar survey design in other Metro Parks and avoided interference by mowing and by prescribed burns as required for management of the prairie. Two points are in the swamp forest (DCF 25 and DCF 26) for comparison purposes and to monitor the forest habitat succession. I marked all points along the trails (DC 1-21, DCF 25, DCF 26) with five-foot rebar poles, yellow Metro Parks survey signs, and fluorescent pink ribbon.

The location of points 1-13 are along the Teal Trail, Harrier Loop and Rail Way trails. Points 14-21 are along the berm on the southern and eastern outside edge of the wet prairie. Points 22-24 are off-trail in the wet prairie savannah and to avoid interference with mowing are not physically marked with rebar. Points 25 and 26 are along the trail of the mitigation swamp forest. The establishment of two point count routes allowed the survey to be accomplished by either two surveyors in one day or over a period of two days by one surveyor. I conducted complete surveys three times during the breeding season to allow for estimation of species detectability. Additionally, I marked with rebar two wetland census points near open water marshes for best viewing and access. Unlike the marked count stations, these viewing points were not 250 meters apart from the other points.

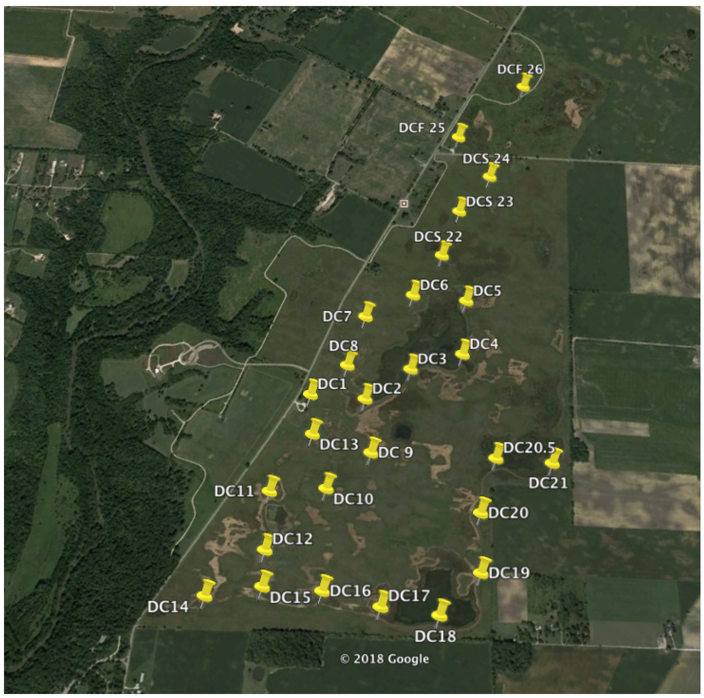

Figure 1. Map of study site in Battelle Darby Creek Metro Park with the 27 marked points.

Field Methods

I conducted three complete surveys in May and early June of 2017 using standard avian point count methods (Ralph et al. 1993). In order to finish sampling in the morning, I split each survey over two days within the same week. The dates of each survey were: survey 1 (5/3/17 and 5/9/17), survey 2 (5/15/17 and 5/17/17) and survey 3 (5/31/17 and 6/1/17). These late spring dates allowed the survey to target both early and late breeding birds. I used five minute, 50m fixed-radius point counts spaced 250 meters apart (Alldredge et al. 2007). Surveys took place between sunrise and four hours after sunrise, when breeding birds are most active and vocal. No surveys occurred during high winds (>20 km/hr) or during precipitation events due to inability to observe birds or accurately detect their calls. During surveys, I recorded all birds seen or heard and noted the detection method used (by song, call, or visual). To estimate the 50m fixed-radius at each point I used a rangefinder (Vortex, Inc.).

Habitat Measurements

At each point, I documented the relative percentages of habitat type (emergent marsh, prairie, open water) and the percent of woody species within the 50 meter radius to compare the bird abundance to habitat characteristics. Distance from edge habitats can have significant direct and indirect impacts on bird populations and is potentially useful for developing management practices since many grassland birds tend to have lower densities near some types of edges (Bock et al. 1999, Hughes et al. 1999). I measured distance to edge habitat (road, tree line, corn field) in meters for every point using aerial photos from Google Earth.

Statistical Analysis

I estimated abundance for the four focal species: Henslow's Sparrow (HESP), Grasshopper Sparrow (GRSP), Marsh Wren (MAWR) and Willow Flycatcher (WIFL) using the occuRN function of "unmarked" package in R (Fiske and Chandler 2011). I selected these four focal species due to their high detection rates and their high-risk status. In order to understand the relationship between abundance and the status of the restoration (e.g. succession), I included habitat variables in the abundance models. Before deciding on the most informative model parameters for each species, I prescreened the data with the full model, which included the following habitat variables: the percentage of prairie habitat, percentage of emergent marsh habitat, percentage of woody vegetation and distance to edge habitat. After removing uninformative variables, the final reduced models for each species consisted of a set of two parameters from the original full model. The model parameters for HESP and GRSP were percent prairie habitat and percent woody vegetation. The model parameters for MAWR were percent emergent marsh and distance to edge habitat and the parameters for WIFL were percent emergent marsh and percent woody vegetation. I set the K value (meant to represent a realistic maximum possible number of individuals at each site) at 10 as a realistic maximum number and to not affect the parameter estimates (Fiske and Chandler 2011).

Results

In 2017, I observed 52 species in the 750 acre wet prairie restoration site (Appendix). Table 1 reports the average abundance and detection probabilities of each species. As the percentage of woody habitat increased, the estimated abundances of HESP and GRSP decreased, while the estimated abundance of WIFL increased (Table 2). The estimated abundance of MAWR did not appear to be related to percent woody habitat. The percentage of prairie habitat appeared to increase with the estimated abundance of HESP and GRSP but was not statistically significant (Table 2 and Fig 2). The percentage of emergent marsh habitat strongly correlated with the estimated abundances of MAWR and WIFL (Table 2 and Fig 3).

	Abundance	Abundance SE	Detectability	Detectability SE
HESP	0.996	0.315	0.191	0.151
GRSP	0.882	0.129	0.077	0.087
MAWR	0.616	0.310	0.459	0.188
WIFL	1.420	0.239	0.077	0.055

Table 1. Estimated average abundance and probability of detection per survey point for each species. The abundance estimates were calculated by averaging the estimated abundance of each species per point at Battelle Darby Creek Metro Park in May and June of 2017.

Variable	**HESP**	**GRSP**	**MAWR**	**WIFL**
Prairie	0.35	0.958	NA	NA
Emergent Marsh	NA	NA	1.02*	1.581**
Percent Woody	-3.51*	-12.989	NA	0.885**
Distance to Edge	NA	NA	1.25**	NA
Mean Density	1.25(0.96)	0.59(0.82)	0.51(0.96)	0.98(1.01)

Table 2. Summary of habitat predictors of abundance for four species from Battelle Darby Creek Metro Park, May-June 2017. Numbers represent model coefficients. Significant values are reported by *=P<0.1 and **=P<0.05. Values in bottom row are mean density per point with the standard deviation in parentheses.

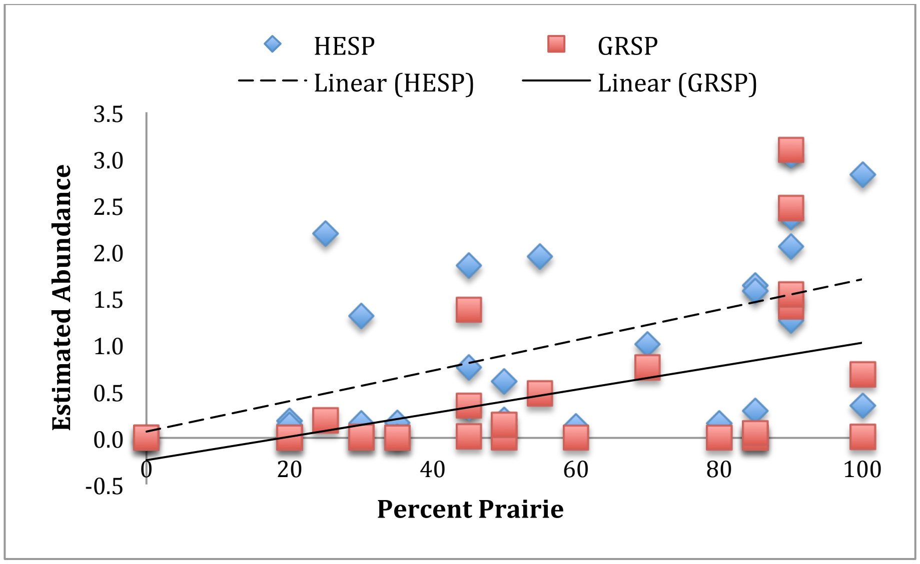

Figure 2. Graph of the linear relationship between the estimated species abundances of HESP and GRSP (raw point estimates) and the percentage of prairie habitat at each point. Species abundances were estimated for the wet-prairie at Battelle Darby Creek Metro Park over three surveys in May and June of 2017.

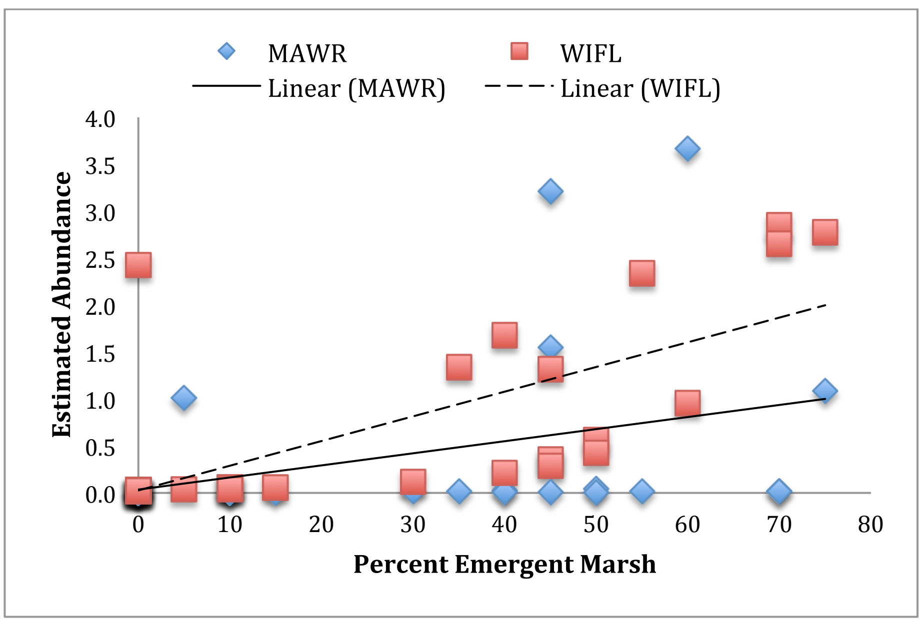

Figure 3. Linear relationship between abundances of MAWR and WIFL and the percentage of emergent marsh habitat at each point. Species abundances were estimated for the wet-prairie at Battelle Darby Creek Metro Park over three surveys in May and June of 2017.

Discussion

This study marks the initiation of a long-term bird monitoring survey to track the successional changes and impacts of the restoration in a mosaic habitat of grasslands and wetlands in Central Ohio. My results serve as the initial baseline assessment since this site's completed restoration in 2012 at Battelle Darby Creek Metro Park. Sustained monitoring after restoration for the different species by tracking abundance is essential for the documentation of how the resulting successional changes will affect habitat quality for various species. This long-term bird species survey will provide insight into both changing habitat composition and required management practices to achieve restoration goals.

Current Metro Parks site management involves spring and fall burning and mowing. Additionally, they are focusing on aggressively treating phragmites, purple loosestrife and callery pear using the herbicide Milestone. Cattails are routinely moved and selectively treated with aquatic glyphosate (Roundup). Managers mow the young cottonwoods every two years and are scheduled to mow again in late 2018 once the ground freezes (John Watts, personal communication).

The estimated abundances of Grasshopper Sparrow and Henslow's Sparrow both showed negative correlations with increased woody vegetation. Invasive non-native *Pyrus calleryana* (Callery Pear; Denune personal observation) comprised a significant portion of the woody vegetation in the prairie habitat. Callery Pear trees are some of the most common urban street trees in Central Ohio. They aggressively spread, excluding native vegetation (Johnson 2018). Continued efforts to remove

Callery Pear and other woody vegetation in the prairie habitat would likely benefit populations of HESP and GRSP.

Routine mowing and/or prescribed burning would reduce woody vegetation. Herkert recommends as a good general guideline to establish a rotational system of prescribed burning, thus providing a mosaic of habitat types for large prairies over 80 hectares (~198 acres). In this system, 20-30% of the habitat area would be burned each year (Herkert 1994). Annually burning only portions of the prairie habitat is critical as larger burned prairies are less likely to attract burn-sensitive bird species such as Henslow's Sparrows. Henslow's Sparrows exhibit a significant preference for unburned areas and reach their highest relative abundance in areas that are in their third or greater growing season since the last burning (Herkert 1994). Their absence from recently burned sites is consistent with their preference for relatively undisturbed, dense vegetation with a well-developed litter layer (Skinner et al. 1984). Conversely, Grasshopper Sparrows tend to be more abundant in recently burned areas as they prefer low- to medium-height vegetation (Herkert 1994, Skinner et al. 1984). Prairie management targeting a mosaic of habitat types through rotational burning will ensure the availability of suitable habitats for both burn sensitive and burn tolerant species.

Maintaining the small patches of young cottonwoods and willows surrounding the wetlands would likely benefit the population of Willow Flycatchers. The estimated abundance of Willow Flycatchers increases with increased woody vegetation in emergent marsh settings. Willow Flycatchers nest in bushes or small trees surrounded by low shrubs and aquatic habitat. Specifically within the woody vegetation, Willow Flycatchers place their nests at the outer edge of shrubs or thicket for ease of access to the nest (Sedgwick 2000). Maintaining pockets of critical willow and young cottonwood habitat will help to sustain and benefit the current population. These small patches of native woody vegetation should not be burned or mowed every year to ensure that there are always some patches of wetland tree species available. Similarly, the dense patches of cattails surrounding the open water of several of the wetlands should be maintained for the Marsh Wrens. During the surveys the Marsh Wrens were only heard or seen in cattails surrounding the open water wetland area. Marsh Wrens utilize cattails for both feeding and breeding. They forage on the stems and leaves of cattails typically near the marsh floor and build their nests in cattails (Kroodsma and Verner 2013). This population of Marsh Wrens is of special importance as the individuals who arrived at the site in 2015 were the first Marsh Wrens to nest in Franklin County since a population in 1989 at Pickerington Ponds Metro Park (John Watts, personal communication). To support the biodiversity of the site, both prairie and emergent marsh habitat should be actively managed to address the opposing habitat needs of these diverse species. Continuing to use a rotational method of burning and mowing along with preserving critical wetland vegetation will serve to accommodate both wetland and grassland bird species.

The estimated species abundances are likely high values due to the very low detectabilities of encountering each species. These low detectability values were surprising as the survey was completed three times. Since the model generated low detectability values, it leads to overestimates at each point. In particular, the WIFL has the highest estimated abundance, yet these birds were only found in a few locations: the points with young willow and cottonwood tree vegetation. This overestimate is due to WIFL low detectability as well as to the habitat model not being specific to vegetation type. The model I used only accounts for the total percent woody vegetation at each point and does not specify Callery Pear vegetation versus young willow and cottonwood vegetation. This means that the model predicts the presence of WIFL at all the points with woody vegetation, even where the suitable habitat (willows and cottonwoods) is not present, thus leading to an overestimate.

Future Objectives

In the short term, the goal of this baseline survey is to begin a process to quantify the success of wetland and prairie restoration through the continued monitoring of indicator species. In the long term, such ongoing monitoring will document changes in bird abundance relative to ongoing habitat succession. The continued long-term monitoring along with documentation of habitat management will allow the analysis of the impact of planned burns on species' habitat usage. Future surveys will be necessary to document the potential recruitment of later successional species. Given relatively low detection probability of some species, I recommend future surveys extend the time duration at each point count to ten minutes. Additionally, a bird song or call recording could be played following the initial survey to increase the probability of detection for less vocal specific species. Further, abundance estimate models should include greater specificity of vegetation type to avoid overestimates. The results of this survey should also be used to assess the necessary number of points and the ideal frequency of surveys.

Acknowledgements

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Appendix

Species List

ACFL – Acadian Flycatcher (*Empidonax virescens*)
AMBI – American Bittern (*Botaurus lentiginosus*)
AMCR – American Crow (*Corvus brachyrhynchos*)
AMGO – American Goldfinch (*Spinus tristis*)
AMCO – American Coot (*Fulica Americana*)
AMRO – American Robin (*Turdus migratorius*)
BARS – Barn Swallow (*Hirundo rustica*)
BHCO – Brown-headed Cowbird (*Molothrus ater*)
BLJA – Blue Jay (*Cyanocitta cristata*)
BWTE – Blue-winged Teal (*Spatula discors*)
CANG – Canada Goose (*Branta Canadensis*)
CHSW – Chimney Swift (*Chaetura pelagica*)
COGR – Common Grackle (*Quiscalus quiscula*)
COHA – Cooper's Hawk (*Accipiter cooperii*)
COYE – Common Yellowthroat (*Geothlypis trichas*)
DCCO – Double-crested Cormorant (*Phalacrocorax auritus*)
DOWO – Downy Woodpecker (*Dryobates pubescens*)
EABL – Eastern Bluebird (*Sialia sialis*)
EAKI – Eastern Kingbird (*Tyrannus tyrannus*)
EAME – Eastern Meadowlark (*Sturnella magna*)
EUST – European Starling (*Sturnus vulgaris*)
FISP – Field Sparrow (*Spizella pusilla*)
GBHE – Great Blue Heron (*Ardea Herodias*)
GREG – Great Egret (*Ardea alba*)
GRSP – Grasshopper Sparrow (*Ammodramus savannarum*)
HESP – Henslow's Sparrow (*Centronyx henslowii*)
HOWR – House Wren (*Troglodytes aedon*)
KILL – Killdeer (*Charadrius vociferous*)
MALL – Mallard (*Anas platyrhynchos*)
MAWR – Marsh Wren (*Cistothorus palustris*)
MODO – Mourning Dove (*Zenaida macroura*)
NOCA – Northern Cardinal (*Cardinalis cardinalis*)
NOMO – Northern Mockingbird (*Mimus polyglottos*)
NRWS – Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)
NSHO – Northern Shoveler (*Spatula clypeata*)
PBGR – Pied-billed Grebe (*Podilymbus podiceps*)
RBME – Red-breasted Merganser (*Mergus serrator*)
RBWO – Red-bellied Woodpecker (*Melanerpes carolinus*)
RNEP – Ring-necked Pheasant (*Phasianus colchicus*)
RWBL – Red-winged Blackbird (*Agelaius phoeniceus*)
SORA – Sora (*Porzana Carolina*)
SOSA – Solitary Sandpiper (*Tringa solitaria*)

SOSP – Song Sparrow (*Melospiza melodia*)
SWSP – Swamp Sparrow (*Melospiza Georgiana*)
TRES – Tree Swallow (*Tachycineta bicolor*)
TUTI – Tufted Titmouse (*Baeolophus bicolor*)
TUVU – Turkey Vulture (*Cathartes aura*)
YEWA – Yellow Warbler (*Setophaga petechial*)
WIFL – Willow Flycatcher (*Empidonax traillii*)
WISN – Wilson's Snipe (*Gallinago delicata*)
VIRA – Virginia Rail (*Rallus limicola*)
VESP – Vesper Sparrow (*Pooecetes gramineus*)

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